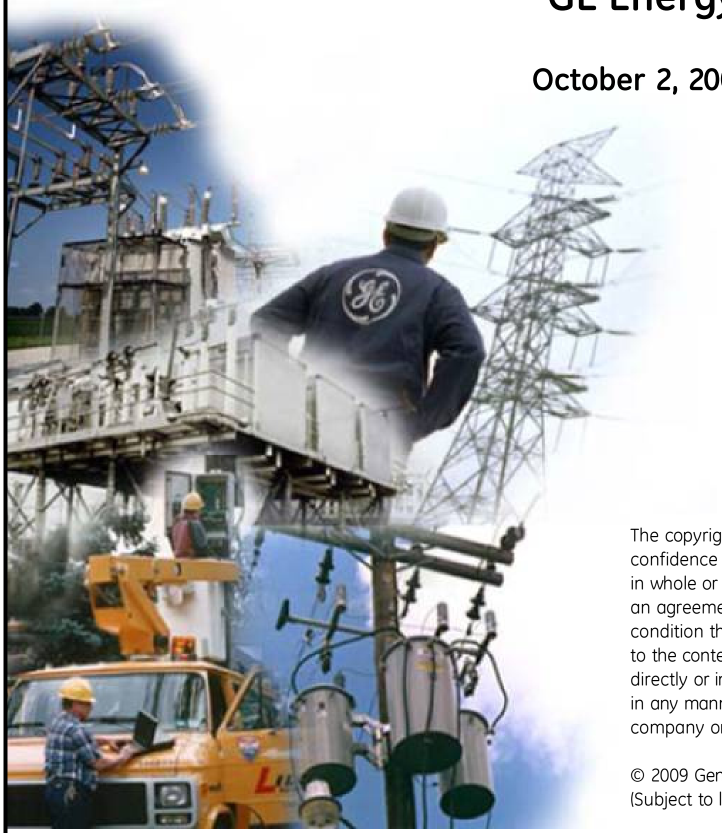
# Smart Grid and Advanced Infrastructure & Services

## Comments to the FCC

Presented by

GE Energy

October 2, 2009



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## 1) Executive Summary

GE Energy is pleased to respond to the FCC's solicitation for comment on NBP Public Notice #2 (GN docket Nos. 09-47, 09-51 and 09-137).

GE is the industry leader in bringing intelligent, innovative solutions to the electricity sector to address economic, social and environmental challenges – smart grid technologies that leverage integration synergies and deliver results. GE's Smart Grid solutions help to:

- *Reduce energy and peak demand resulting in reduction of $CO_2$ emissions*
- *Maintain/Improve system reliability*
- *Empower consumers to lower energy bills*
- *Lower integration and O&M costs*
- *Ensure interoperability, security and open standards applied to end-to-end integration of the smart grid solution*

GE Energy brings more than software, hardware and services to a Smart Grid deployment. We have an end-to-end vision and roadmap of an integrated and large-scale smart grid deployment. We have the technology breadth across the many businesses in GE from generation to T&D and industrial solutions: renewable generation; battery energy storage; power equipment; engineering management and operations software; substation and field controllers and protection relays; and consumer energy management solutions. We have the depth in each technology around the expertise, experience and project services to deploy our solutions. We also have world-class research and development centers that deliver advanced technologies to the smart grid technology roadmap.

## 2) GE's Smart Grid Position and Strategy

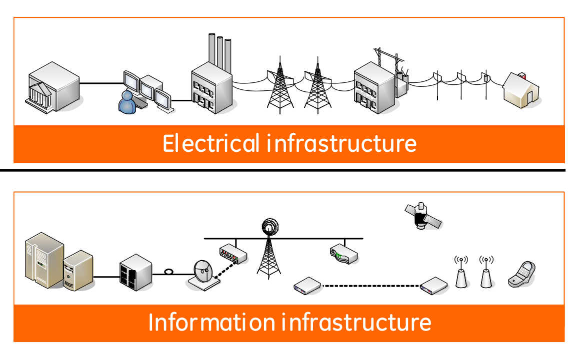
The Smart Grid is the future of the new power industry and the time is now for making headway with the Smart Grid. The Smart Grid provides enterprise-wide solutions that deliver far-reaching benefits for both utilities and their end customers. Utilities that adopt these Smart Grid technologies can reap significant benefits in reduced capital and operating costs, improved power quality, increased customer satisfaction and a positive environmental impact. With these capabilities come questions:

- What is the potential of the Smart Grid?
- Is there one set of technologies that can enable both strategic and operational processes?
- How do the technologies fit together?
- How do you leverage benefits across applications?

GE Energy can help utilities answer these questions and provide the means to deploy and support long-term, integrated technology solutions.

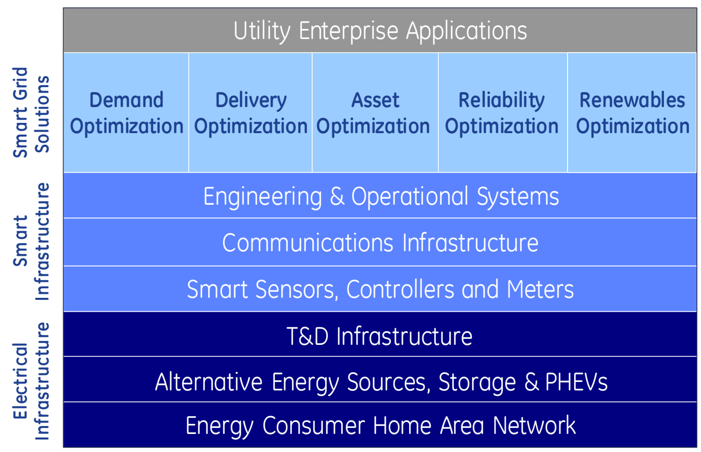
Smart Grid is not about doing things much differently to what we are doing today, but more of sharing of communication infrastructures, filling in product gaps, and leveraging existing technologies to a greater

**The Integration of Two Infrastructures**



extent while driving a higher level of integration to realize the synergies across enterprise integration. As with any other investment, focus should be on how it benefits the shareholder and how it benefits the customer. The Smart Grid is a framework for solutions. It is both revolutionary and evolutionary in nature, because it can significantly change and improve the way we operate the electrical system today, while providing for ongoing enhancements in the future. It represents technology solutions that optimize the value chain, allowing us to squeeze more performance out of the infrastructure we have and to better plan for the infrastructure we will be adding. It requires collaboration among a growing number of interested and invested parties, in order to achieve significant, systems level change. The smart grid will embrace more renewable energy; increase grid efficiency and transfer real-time energy information directly to the consumer – empowering them to make smarter energy choices.

Energy technologies can revolutionize efficiency and renewable solutions, and, in the process, the electrical power grid that remains little changed since its inception. While the grid is a marvel in engineering design and may, indeed, be one of mankind's greatest achievements, it has yet to be transformed into a modern grid, a sustainable grid, a truly smart grid that takes advantage of proven, cleaner, cost effective technologies that are available or in development today. GE believes that the Smart Grid is an essential component to addressing the energy demand, security and environmental challenges we face.




At GE, our perspective is that the Smart Grid is the integration of electrical and communication infrastructures, and the incorporation of process automation and information technologies with our existing electrical network. Smart Grid is essentially modernizing the 20th century grid for a 21st century society. Of utmost importance are the tangible, quantifiable and meaningful results:

- Improving the utility's power reliability, operational performance and overall productivity
- Delivering increases in energy efficiencies and decreases in carbon emissions
- Empowering consumers to manage their energy usage and save money without compromising their lifestyle
- Optimizing renewable energy integration and enabling broader penetration

GE understands the end-to-end Smart Grid solution and can supply the enabling technologies. GE Energy's approach to managing change is to facilitate a migration path through a phased implementation approach that will help remove the barrier of organizational thinking, and help realize incremental benefits while achieving the intended goal of a more comprehensive Smart Grid.

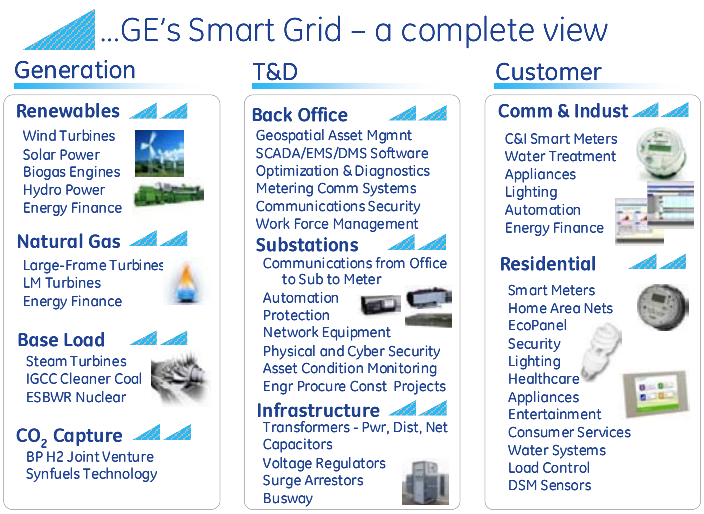
## 3) The GE Smart Grid Advantage

***The Strength of Our Company***

GE Energy (part of General Electric Co.) (http://www.gepower.com/home/index.htm) is one of the world's leading suppliers of power generation and energy delivery technologies. GE Energy, which earned 2008 revenue of US$29 billion is based in Atlanta, Georgia, and participates in all areas of the energy industry, including; transmission and distribution; generation such as, coal, oil, natural gas and nuclear energy; renewable resources such as water, wind, solar and biogas; and other alternative fuels. Numerous GE Energy products are certified under GE's ecomagination[SM] program, which is a corporate-wide initiative to aggressively bring to market new technologies that will help customers meet pressing environmental challenges.

***Integrated Solutions to Support a Comprehensive Smart Grid Solution***

GE Energy has been in the transmission and distribution business for over 75 years and has a comprehensive offering of products and solutions that enable Smart Grid processes and help decision makers drive greater productivity, energy efficiency and customer satisfaction while maintaining profitability. Integrated technologies span the many businesses of GE. Thanks to some far-sighted decisions several years ago, and through strategic partnerships, GE has a comprehensive line of solutions for a Smart Grid deployment. The breadth of our portfolio includes power equipment, controllers, Intelligent Electronic Devices (IEDs), smart meters and transformer management systems that enable utility personnel to further improve asset performance and network reliability, while meeting customer needs. Our portfolio also includes a suite of business intelligence; grid management and engineering and workforce software applications to help utilities safely and efficiently operate, automate and manage critical transmission and distribution assets. GE Energy also offers a wide range of services focused on the various needs of utilities. From project planning and design to commissioning, GE's project organization, in conjunction with our partners, team up with utilities worldwide to execute successful turnkey programs and deliver innovative solutions. We also provide upfront consulting and technical expertise to help utilities through the analysis and decision making process. Our businesses demand that we keep current with evolving technology, regulatory, and best practice trends within the industry.




All of these products come together to create a new business environment for the utility. A true Smart Grid infrastructure, built around a single, integrated vision, will accomplish something that until now has been a challenge for all utilities: increasing network performance while reducing capital and operating expenditures. Comprehensive data capture, combined with intelligent automation and integrated business systems, will allow faster fault restoration, reduce fault impact, reduce load on network equipment, and reduce the amount that needs to be spent on new asset deployment. GE believes that success in such a broad-range of technologies requires excellence across several business processes and organizations in a utility. A successful implementation requires not only outstanding products, but also systems integration experience and organizational change management.

***Product and Application Expertise***

GE Energy is the industry leader in providing smart metering and other smart grid technologies to the electric utility industry. Around the world, leading utility companies are moving ahead with our benchmark Smart Grid solutions. Our customers are using our solutions to measure energy consumption at customer premises, effectively manage network operations, improve customer service, automate asset management functions, streamline network documentation processes, optimize network design, build new efficiencies into workflow processes, and address many other vital business needs.

Superior technology is important, but it is the expertise and experience that make it work! Our team includes members that have many years of utility and project implementation experience, many of those years directly related to complex system implementations. No other vendor can bring this depth and quality of experience to the solution. Our consulting services provide the foundation for strategic partnerships and successful long-term relationships with our customers.

Consider the following:

- Extensive expertise and experience delivering a variety of hardware and software solutions to a wide range of utility customers
- The ability to manage and drive projects from concept to deployment through continuous improvement
- A collaboratively structured engagement with direction and valuable data to move forward with a Smart Grid initiative
- A cross-competency approach that considers business process requirements, technical architecture, implementation considerations, and change management issues
- A staff of senior professionals with direct experience providing such engagements to utility clients
- Ready access to GE subject matter experts in applications and technology

***Depth of Resources***

GE Energy brings a large, integrated global service organization. We can draw upon the considerable combined resources of GE Power Generation, T&D, C&I, Digital Energy and our Global Research Center. GE would place the combined wealth of expertise and manpower represented by these coordinated teams head and shoulders above any other supplier. Our projects team is committed to meet the technical, quality, and schedule requirements of any complex project.

***Thought Leadership and Industry Participation***

Early on, we recognized that any efforts undertaken by the utility to build intelligence into the electrical network must be tightly coupled with regulatory body positions and initiatives, and governmental policy. These organizations often provide the incentive, justification, and mandates for the utility to make the initial investments (e.g., smart metering and the deployment of two-way communications) that can be leveraged into additional "intelligent" network solutions. Some examples of GE's participation in Smart Grid efforts and forums include:

- US Department of Energy (DOE) Electricity Advisory Committee (EAC)
- Smart Energy Alliance (SEA)
- Gridwise Alliance
- EPRI IntelliGrid and Open AMI
- IEEE Smart Grid Coordinating Committee
- IEC Technical Committee 57
- ZigBee Alliance
- HomePlug Powerline Alliance
- Center for Sustainable Electricity and Distributed Generation
- Society of Automotive Engineers (SAE)
- American National Standards Institute (ANSI)
- UtilityAMI

***Strength in Supplier Relationships***
Based upon the vast number of Smart Grid projects that we have successfully deployed, GE Energy has developed many strong relationships with a wide variety of suppliers and subcontractors. Based upon this experience, we are able to select supplier partners that maximize the strength of our team.

***Our Solution is backed by the Strength of General Electric***
In today's uncertain business environment, it is important for companies to align themselves with vendors that combine high integrity with financial strength. Backed by one of the most respected and financially sound companies in the world, GE Energy offers the assurance that our solution will provide the long-term support that is needed for long-term smart grid deployments.

***GE Energy has the "Endurance" to Implement a Smart Grid Solution over a Multi-Year Horizon***
GE Energy is working closely with several major utilities to help develop, demonstrate and deploy Smart Grid solutions.

## 4) A Smart Grid Partnership

Comprehensive Smart Grid programs require working with a vendor with the technology, expertise, and breadth of skills, experience and resources to implement such a large-scale, multi-year, multi-million dollar program. GE offers EDP the opportunity to establish a working partnership with GE to plan and deploy a long-term Smart Grid initiative. A partnership with GE is a collaborative, relationship-driven solution for implementing electrical infrastructure improvement programs. It allows both GE and EDP to achieve financial and business objectives by performing work according to an agreed-upon procedure. The Partnership builds mutual trust, honesty, and openness, creating a results-oriented environment that contributes to success. While some elements of the Partnership are core to its success, it is customized to meet the particular needs of EDP and GE, focusing on mutual benefits and business objectives. GE sees this Partnership as a natural progression from the existing strategic relationship between GE and EDP. GE can provide products and services, both directly and through its alliance network, to design, implement and deploy Smart Grid infrastructure. By combining our end-to-end product solutions and broad alliance program, GE Energy can fully meet EDP's requirements and successfully deliver EDP's Smart Grid program.

We offer EDP open dialog on a partnership with GE for a Smart Grid deployment program. We have similar arrangements with other customers, such as AEP, where we successfully work together as a team to address the requirements and drive the deliverables of phased deployments of Smart Grid enabling technologies. The partnership provides open, two-way interaction between GE and EDP. Our partnership approach relies on the following framework:

AEP AMERICAN ELECTRIC POWER

NEWS from AEP

MEDIA CONTACT:
Pat D. Hemlepp
Director, Corporate Media Relations
614/716-1620

ANALYSTS CONTACT:
Julie Sloat
Vice President, Investor Relations
& Strategic Initiatives
614/716-2885

FOR IMMEDIATE RELEASE

**AEP, GE ENERGY WILL PURSUE DEVELOPMENT, INTEGRATION, DEPLOYMENT OF ENHANCED ENERGY DELIVERY, ADVANCED METERING TECHNOLOGIES**

***AEP seeks sites for initial deployment to 200,000 customers, goal of 5 million by 2015; technologies improve overall efficiency, enable customers to control electricity costs***

COLUMBUS, Ohio, Oct. 4, 2007 – American Electric Power (NYSE: AEP) and GE Energy, a business unit of General Electric (NYSE: GE), will pursue the development, integration and deployment of advanced energy delivery infrastructure and metering technologies in an agreement that will enhance the consumer's ability to control and reduce electricity costs as well as improve the overall efficiency of electricity use.

The companies have signed a memorandum of understanding and are continuing discussions to reach a definitive agreement to develop technology platforms and programs that will transform how electricity is delivered to – and used by – consumers.

The AEP-GE initiative "is the first in the industry to address the full energy pathway from the power plant to the home," said Michael G. Morris, AEP's chairman, president and chief executive officer.

AEP will deploy advanced metering (often referred to as smart meters) and the enhanced infrastructure technology resulting from the partnership with GE in two regions – representing approximately 200,000 customers – by the end of 2008, if necessary regulatory approvals are received. The advanced metering, combined with special rate plans, will allow customers to better understand their energy consumption and, by utilizing signals indicating time-of-day prices, reduce their electricity costs. AEP will select specific locations for this initial deployment after evaluating potential sites in its 11-state service area. Primary selection criteria will be urban/suburban areas with 50,000 to 100,000 customers.

AEP plans to have the advanced metering and enhanced infrastructure technologies in use to serve a million of its customers by the end of the decade and in use to serve its entire customer base of more than 5 million by the end 2015, pending appropriate regulatory approvals in the

- Appointed subject matter teams from both GE and the utility fully engaged to ensure the optimum solution is delivered
- We assign a project manager to coordinate and lead the partnership efforts, but encourage team-to-team interaction between GE and the utility
- We consider legacy system interfaces required and a suitable migration path to an optimum integration of Smart Grid technologies
- Work together to compile business cases in order to define the most effective Smart Grid deployment roadmap
- Support of pilots or phased deployments of Smart Grid technologies in terms of product introduction, product development, and deployment
- A partnership structure - when one succeeds, we both succeed

## 5) GE's Smart Grid Vision

GE's high-level vision of the Smart Grid Architecture is shown in Figure 1 below:

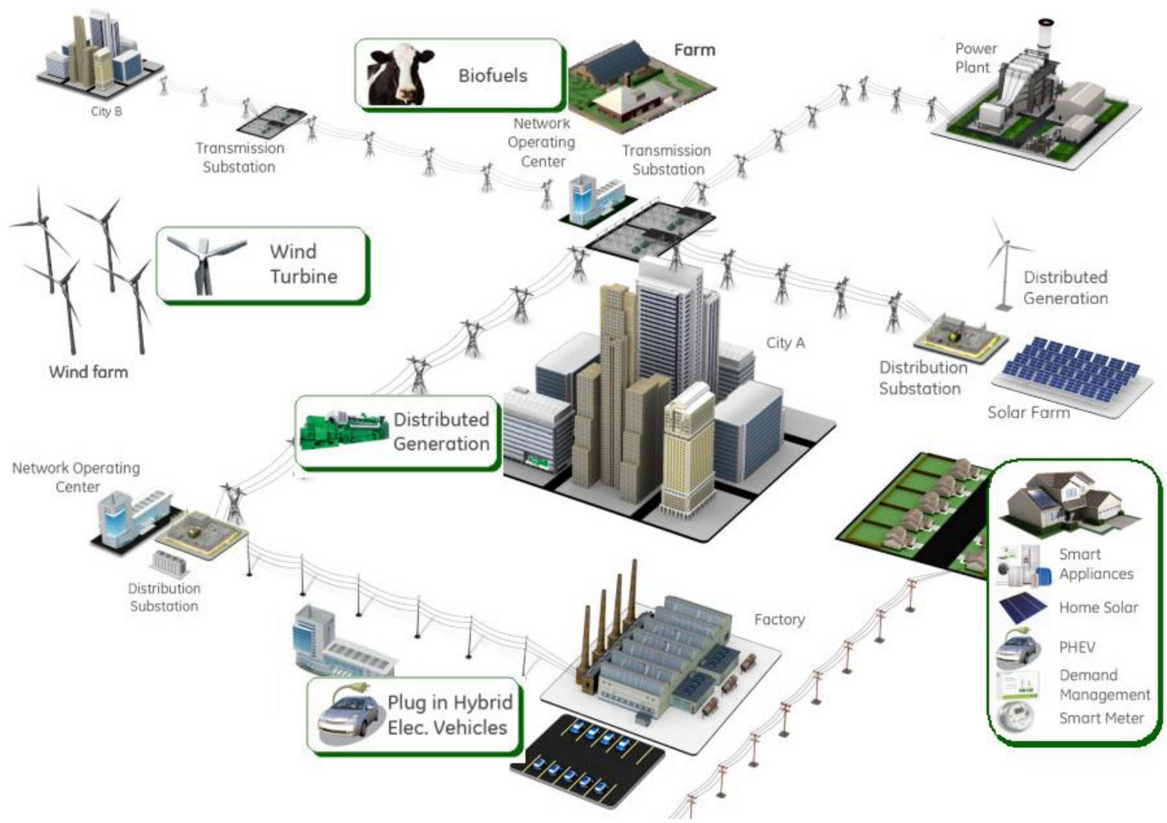



**Figure 1: GE's High Level Vision of the Smart Grid**

GE Energy has identified several core Smart Grid enabling technologies that are the immediate focus of our Smart Grid portfolio offering:

- AMI (Advanced Metering Infrastructure)
- Delivery Optimization
  - Grid Efficiency
  - Grid Reliability
- Demand Optimization
  - Customer Empowerment
  - Demand & Supply Management
- Transformer Asset Optimization
  - On-Line Monitoring & Diagnostics
  - Advanced Maintenance Services
- Reliability Optimization
  - Transmission system WAMS (Wide Area Measurement System)
- Renewables Optimization
  - Integration, monitoring and control of alternative energy sources

## 6) Suitability of Communications Technologies

Smart Grid applications are being deployed using a variety of public and private communications networks. We seek to better understand which communications networks and technologies are suitable for various Smart Grid applications.

a. What are the specific network requirements for each application in the grid (e.g., latency, bandwidth, reliability, coverage, others)? If these differ by application, how do they differ? We welcome detailed Smart Grid network requirement analyses.

Response

We'll first identify and then define the "applications" that the communications network will need to support. The applications can generally be categorized in Home Area Network (HAN) based applications (metering data, TOU and price data, local generation via a renewable resource), Distribution based applications (distribution substation, distribution feeder, distribution based renewable generation), Transmission based applications (transmission substations, transmission network or wide area network phasor type devices), and mobility type applications for voice and data connectivity of the utility field work force. We'll generically try to define the various requirements for each application in Table 1, however this is somewhat generic at this point. GE is currently developing a much more extensive data and traffic model which will build out the data and traffic requirements much more specifically for the applications. GE would be happy to share this traffic model with the FCC once it is available later this year.

| Application | Coverage Requirement | Data/Device | # of Devices | Latency Needed |
|---|---|---|---|---|
| HAN | Generally entire service territory | L | H | L/M |
| Distribution | Strategic - critical subs or feeders | M/H | M | M |
| Transmission | Strategic - critical subs or feeders | H | L | M/H |
| Mobility | Generally entire service territory | H | L | H |

Table 1 – Network Applications and Associated Requirements

The requirements for the communications network that would be deployed for Smart Grid applications need to cover several areas of which you mentioned above. It's likely not rationale to expect that 1 network could be used to provide all the required connectivity, however it is possible given the right circumstances around geographic territory, population density, etc. From a utility perspective, one of the most important requirements is coverage. Utilities have to provide power, and therefore connectivity, to ALL of their customers regardless of where they live. This requirement may in fact be one of the more important aspects of the discussion. Given this requirement, there is NO network that is in place today that satisfies this point. Arguably, the types of network that could satisfy some of these requirements today would be the digital cellular carriers 2G and 3G networks or the telephony based wires networks that are substantially in place from the RBOC days, however these have their own sets of issues which will be discussed throughout our response.

b. Which communications technologies and networks meet these requirements? Which are best suited for Smart Grid applications? If this varies by application, why does it vary and in what way? What are the relative costs and performance benefits of different communications technologies for different applications?

Response

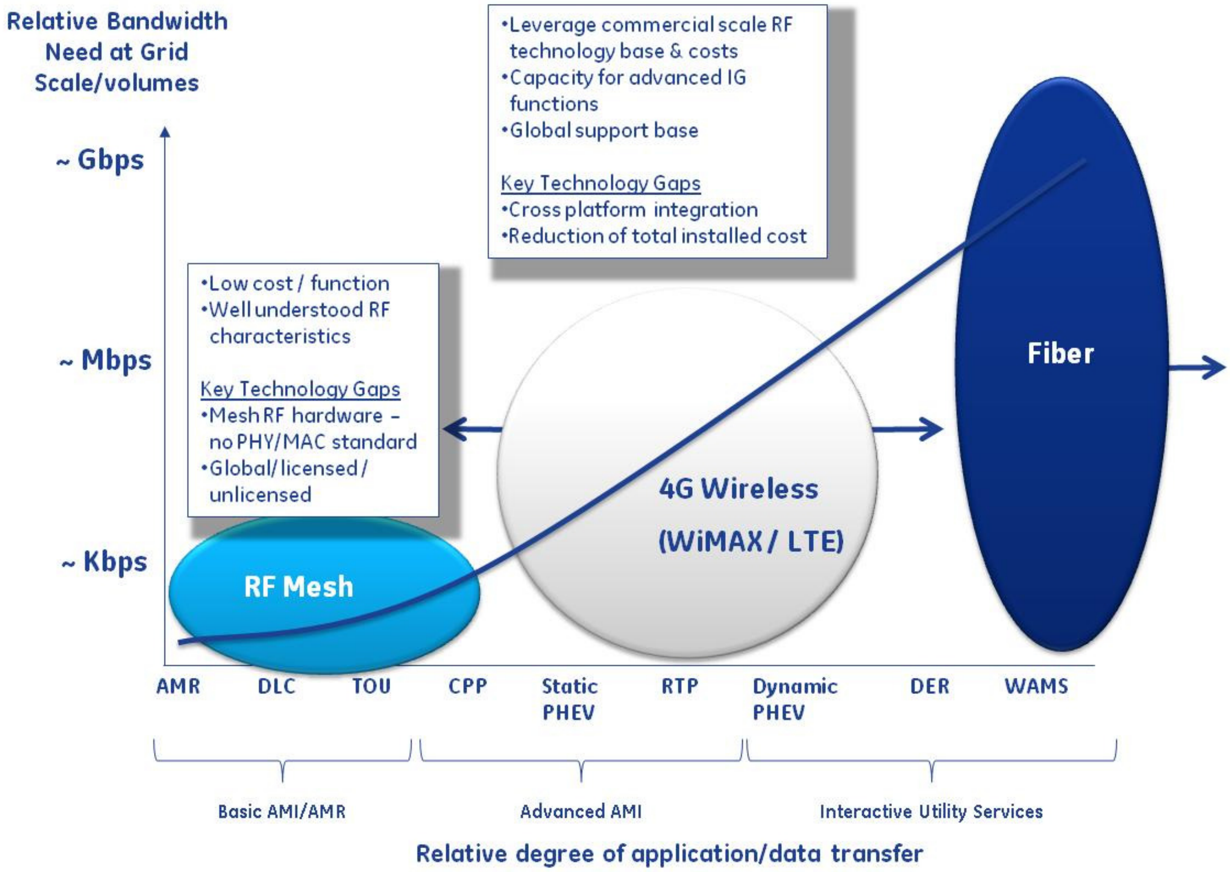



Table 2 – Application Specific Requirements

Table 2 above would be indicative of the types of Smart Grid applications (x-axis) and a general representation of the required bandwidth for each application. We've also included some technology characterizations that could support the given application.

c. What types of network technologies are most commonly used in Smart Grid applications? We welcome detailed analysis of the costs, relative performance and benefits of alternative network technologies currently employed by existing Smart Grid deployments, including both "last mile," backhaul, and control network technologies.

Response

Current Smart Grid deployments are comprised of different public and private technologies. Cellular and public WiMAX technologies are often used for higher latency and/or non-critical systems. Private network are typically used for low latency and/or mission critical solutions, unlicensed ISM-band mesh networking and WiMAX for the advanced metering infrastructure (AMI), or last-mile connection, licensed and private unlicensed point to point radios and private 3.65 GHz WiMAX networks for backhaul.

d. Are current commercial communications networks adequate for deploying Smart Grid applications? If not, what are specific examples of the ways in which current networks are inadequate? How could current networks be improved to make them adequate, and at what cost? If this adequacy varies by application, why does it vary and in what way?

Response

Commercial communications networks, such as mobile phone systems, are deployed to provide voice and data services to their paid subscribers. The cell sites that comprise the network are provisioned with radio/spectrum and backhaul resources based on existing and anticipated paid subscriber traffic. Additionally, their mobile telephone switching office is provisioned with switch resources based on traffic expectations. Extending a commercial mobile phone system to include Smart Grid communications would require considerable additional resources to be deployed throughout an existing network and would likely impact system performance, due to the limited spectrum allocated to the service provider. These existing cell sites will ultimately require new frequency plans, traffic prioritization and antenna system modifications to meet the increased demand and minimize interference within their network. Additional cell sites (i.e. through cell splitting) will also be required to meet the increased demand presented by the Smart Grid; these cell sites will need significant financial resources for their design, fabrication and deployment. At the core of this issue is the question: will paying cellular subscribers have priority over Smart Grid communications? While some Smart Grid use-cases will be able to tolerate long latencies, those focused on control will not. The cell phone provider will have to guarantee the availability of a specified amount of connectivity to the electric utility, to the detriment of their paying subscribers. This is especially important after a natural disaster or power outage when commercial cellular systems become overloaded when at the same time Smart Grid communications traffic will be vital to maximizing the system performance. Current cellular network do not have the ability to priorities data traffic buy user or user type.

It is for some of the above reasons that GE has developed some interest in coordinating a synergistic build plan for the newer 4G technologies and network deployments. We believe that there an opportunity for the telecommunications companies and the electric utilities to collaborate on a network use model that maximizes the dollars spent on 4G networks. Data prioritization and Virtual Private Networking (VPN) technologies can allocate bandwidth to utility applications and provide the services that are needed under contractual SLA's (Service Level Agreements). As we will note in the balance of this response, this 1 network is likely not capable of being used everywhere and for all applications.

e. How reliable are commercial wireless networks for carrying Smart Grid data (both in last-mile and backhaul applications)? Are commercial wireless networks suitable for critical electricity equipment control communications? How reliably can commercial wireless networks transmit Smart Grid data during and after emergency events? What could be done to make commercial wireless networks more reliable for Smart Grid applications during such events? We welcome detailed comparisons of the reliability of commercial wireless networks and other types of networks for Smart Grid data transport.

Response
For Smart Grid to be fully functional in emergency situations the system needs to implement priority data traffic levels to ensure critical Smart Grid traffic has priority over individual paid subscriber data. The system will also need to support extended durations of battery backup during power loss so the utilities can still operate the network if power is lost for long periods of time. As was noted above, the reliability of the commercial network could be substantially improved given redundant power supply (primary and back-up). This is yet another area where the utility (which could provide the primary and back-up power facilities) and the telecomm provider could forge a more powerful relationship.

## 7) Availability of Communications Technologies

Electric utilities offer near universal service, including in many geographies where no existing suitable communications networks currently exist (for last-mile, aggregation point data backhaul, and utility control systems). We seek to better understand the availability of existing communications networks, and how this availability may impact Smart Grid deployments.

a. What percentage of electric substations, other key control infrastructure, and potential Smart Grid communications nodes have no access to suitable communications networks? What constitutes suitable communications networks for different types of control infrastructure? We welcome detailed analyses of substation and control infrastructure connectivity, potential connectivity gaps, and the cost-benefit of different alternatives to close potential gaps.

Response
Useful information regarding substation communications capabilities will be provided by the NTIA which is conducting a broadband mapping of substations.- http://www.ntia.doc.gov/press/2009/BTOP_mappingtotals_090909.html

- ✓ Utilities will use fiber optic communications for most or all electric facilities operating at or above 66kV.

- ✓ Microwave communication may be installed in rural areas, where cable construction may be limited due to permits or cost. This way, all legacy services (protective relaying, SCADA, and voice) and advanced Smart Grid services are supported.
- ✓ New substations required for load growth are constructed with fiber optic communications, which supports legacy services and prepares the site for future advanced Smart Grid services.
- ✓ Additionally, equipment upgrades at 230kV substations (relay upgrades) have driven the need for communication network enhancements to meet redundancy requirements for protection. These enhancements have contributed to the increase in grid reliability from diverse communication links.
- ✓ Utilities will likely using broadband wireless and satellite technologies to close the gaps in rural areas. Gaps exist in very rural areas where 115kV substations are much farther apart and are distant from customers. Fiber optic and microwave installation in these areas are either impractical or cost prohibitive.

b. What percentage of homes have no access to suitable communications networks for Smart Grid applications (either for last-mile, or aggregation point connectivity)?

Response

At the moment, a very small percentage of homes in the US have suitable AMI network coverage available to them. The most robust of these networks provide somewhere between 100 kbps and 250 kbps, while other solutions being installed today only provide about 20 kbps throughput. In our opinion, these lower throughput networks will not be capable of providing the required functionality ultimately required by the utilities.

c. In areas where suitable communications networks exist, are there other impediments preventing the use of these networks for Smart Grid communications?

Response

Utilities need to have priority access to the data on their networks. This is especially true in crisis situations where wireless system, being the more reliable than wired communications become overloaded an unusable for mission critical systems.

d. How does the availability of a suitable broadband network (wireless, wireline or other) impact the cost of deploying Smart Grid applications in a particular geographical area? In areas with no existing networks, is this a major barrier to Smart Grid deployment? We welcome detailed economic analyses showing how the presence (or lack) of existing communications networks impacts Smart Grid deployment costs.

Response

As we have stated before, we believe there is synergy for the use of "suitable" broadband networks (in our definition this would be one that utilizes 4G technology) and can enable the deployment of the Smart Grid. The total cost of deploying 1 network vs. 2 networks is more economically efficient, however current rate based decisions and economics need review to incentivize the utilities to make these decisions. As we've indicated earlier, one technology will not meet all the battery back-up, latency, bandwidth, reliability and coverage requirements and be justified in a rate case. Deploying a high performance, cost effective communication network will require a fabric of public and private, wired and wireless communication networks that fit together in a scalable and seamless fashion that are built over time.

## 8) Spectrum

Currently, Smart Grid systems are deployed using a variety of communications technologies, including public and private wireless networks, using licensed and unlicensed spectrum. We seek to better understand how wireless spectrum is or could be used for Smart Grid applications.

a. How widely used is licensed spectrum for Smart Grid applications (utility-owned, leased, or vendor-operated)? For which applications is this spectrum used? We welcome detailed analyses of current licensed spectrum use in Smart Grid applications, including frequencies and channels.

Response

Currently US utility companies use proprietary networks on licensed spectrum at frequencies below 1 GHz. These channels have bandwidths between 5 kHz and 25 kHz and support data rates up to 32 kbps. These systems can connect devices over long range paths but lack the bandwidth for many applications. There are wider bandwidths proposed in the 700MHz band but the band is in regulatory limbo. Specifically for metering applications, most utilities already have their large revenue customers (Consumer and Industrial customers) networked primarily over licensed spectrum made available by large carrier networks. Canada has recently approved the use of the 1800 – 1830 MHz licensed band. New technical rules will be developed for 1800-1830MHz radio systems carrying traffic exclusively for the maintenance and management of the electricity supply. Such a band would enable real-time mission critical broadband applications.

Internationally, particularly in Australia, utilities are strongly considering 4G licensed spectrum for their Smart Grid applications. This spectrum is essentially leased and then vendor-operated.

b. How widely used is unlicensed spectrum? For which applications is this spectrum used? We welcome detailed analyses of current unlicensed spectrum use in Smart Grid applications, including frequencies and channels.

Response

**Low data rate** systems such as frequency hopping spread spectrum systems have been used very successful for long-range networks at data speeds to about 250kbps. These system use frequency diversity and redundancy to provide very reliable links with very good resistance to interference.

**Broadband** short range systems such as IEEE802.11 provide usable data rates at 1-100Mbit/s at distances of ~300 feet.

**Broadband Point to Point** (ptp) radio links provide very high bandwidth with speeds to 155Mbit/s and higher using highly directional antennas and advanced modulation techniques.

**Broadband Point to multi-Point** (ptmp) long-range systems have been used successful in the 3.65GHz band. The band requires users to register and file the location of devices. This allows users to work around issues and maximize performance. Broadband ptmp in the 2.4GHz ISM band and 5.8GHz ISM band has met with mixed results as interference can be significant and change suddenly

c. Have wireless Smart Grid applications using unlicensed spectrum encountered interference problems? If so, what are the nature, frequency, and potential impact of these problems, and how have they been resolved?

Response

Utilities have successfully used unlicensed spectrum for large AMR deployments and SCADA applications. Many smart grid applications such as AMI; protective relaying, distributed generation monitoring & control, protective relaying, outage detection applications are in small scales deployments using proprietary systems. Utilities will have the opportunity to deploy standards based efficient, affordable wireless technology in unlicensed spectral bands enabling the creation of large Smart Grid networks. The key to successful wireless deployment will be appropriate system design. Many of these issues are being addressed by the various standards development organizations.

Unlicensed bands are a good choice for current and future deployments of some Smart Grid applications. A wide range of increasing application demands can be enabled through additional dedicated use spectrum and more efficient use of the unlicensed bands. While more spectrum is one way to address increased application demands, higher spectral efficiency, such as through adopting newer, more efficient and reliable digital techniques, can also meet these requirements without consuming increased spectral resources. This can be seen in the increasing efficiency and intelligence of ISM band technologies, which make increasingly better use of scarce spectrum.
Reliability does not come exclusively from the type of spectrum used, but from the system design. We all agree that spectrum and wireless infrastructure used to support the availability of basic necessities like water, gas and electricity must be available at a reasonable cost. Increased spectral efficiency and new interference mitigation techniques, such as CSMA, LBT,

random back-off, and their support in many standards, as well as standards mandating good coexistence, further support the use of unlicensed spectrum. Unlicensed regulations need to ensure fair access to the unlicensed spectrum. For example, the recent addition of digital modulation in the unlicensed bands allows users to coordinate transmits in time and frequency over a large area such as a city. This allows a single user can simultaneously use the entire channel and significantly degrade performance of all other users.

d. What techniques have been successfully used to overcome interference problems, particularly in unlicensed bands?

<u>Response</u>
Many successful, broadly deployed technologies using unlicensed spectrum.  The strategy is dependent on the latency distance, data speed and bandwidth available. Often to get one performance metric we must sacrifice another. Examples of interference mitigation include methods such as advanced modulation, DSSS, OFDM, CSMA, LBT, random back-off and adaptive frequency hopping. Radio interference problems can further be reduced by smart software, smart antennas and efficient coding algorithms. Most systems use a combination of these techniques appropriate to their application environment.

The Part 15 rules were created to enable many users to share large blocks of unlicensed spectrum. If the FCC were to allocate new spectrum for use in Smart Grids it should carefully consider the types of applications it is proposing to enable and the related spectrum access and sharing rules. It is worth noting that standards organizations such as the IEEE 802 wireless networking standards are designed to provide equal and fair access to the spectrum allowing large numbers of users to efficiently share use of the radio channels.

Not all products on the market work to maximize the spectrum usage in unlicensed bands. To the contrary some take the “Bully Approach” using spectrum wastefully constantly transmitting even when no data is present and further coordinating digital transmitters across frequency, space and time domains to ensure they fully use the unlicensed band. FCC Part 15 rules must limit this miss-use of the channel and prevent unfair coordination between digital transmitters that creates simultaneous harmful interference across the entire band to all but the coordinated system. A single coordinated system should have a ceiling on the percentage of the band it can use simultaneously. By simply limiting the power spectral density to 8dBm / 3kHz a densely deployed coordinated system can raise the noise floor in a geographic area by 50+ dB significantly reducing the performance of all users in the band except for the user creating the interference.

Well-designed unlicensed products can withstand a great deal of interference before they fail. Wireless devices can communicate in environments where interference is significant using a variety of techniques to mitigate the effect of interference. The FCC must ensure that rules make interference from each interfering device random so that numerical methods can statistically be used to create a highly reliable network.

e. Are current spectrum bands currently used by power utilities enough to meet the needs of Smart Grid communications? We welcome detailed studies and discussion showing that the current spectrum is or is not sufficient.

Response

The current bandwidth is not enough if one network were to be utilized for all applications. The Smart Grid system, if built using 1 network technology, would require a similar dedicated spectrum such as the 1.8GHz band being allocated in Canada. Conversely, utilities that chose to run lower data requirement applications over ISM bands and then use higher data requirement applications over other technologies, this would provide for a similar and effective approach. Reliable high bandwidth systems capable of long range connectivity require a high bandwidth, high power and controlled co-channel interference. Low bandwidth systems use a small portion of the unlicensed band. Therefore wireless devices can create highly reliable connections using coding, redundancy and diversity. Broadband systems use a significant portion the entire unlicensed bands they occupy and are therefore subjected to more interference with few degrees of freedom to overcome the interference. Systems like WiMAX work best in a licensed channel where frequency planning and controlled interference ratios allow the system to use the higher order modulation techniques enabling highly efficiency use of the spectrum.

f. Is additional spectrum required for Smart Grid applications? If so, why are current wireless solutions inadequate?

   i. Coverage: What current and future nodes of the Smart Grid are not and will not be in the coverage area of commercial mobile operators or of existing utility-run private networks? We welcome detailed descriptions of the location, number and connectivity required of each node not expected to be in coverage.

      Response

      Outside of urban areas reliable public coverage is spotty or non-existent. Currently public carriers are focused at providing ubiquitous voice with some level of data coverage. The quality of service is far from consistent.

   ii. Throughput: What is the expected throughput required by different communications nodes of the Smart Grid, today and in the future, and why will/won't commercial mobile networks and/or private utility owned networks on existing spectrum be able to support such throughputs? We welcome detailed studies on the location and throughput requirements and characteristics of each communications node in the Smart Grid.

      Response

      Critical utility services should not have to compete with consumer use of the network, which can lead to congestion of the network, especially at critical times. The needs of consumers are very different from the mission critical communication required by the Smart Grid. Commercial networks experience maxim load during critical times such as natural disasters. Without the ability to priorities users, throughput could disappear when it is needed most.

iii. Latency: What are the maximum latency limits for communications to/from different nodes of the Smart Grid for different applications, why will/won't commercial mobile networks be able to support such requirements, and how could private utility networks address the same challenge differently?

Response

The needs of consumers are very different from the mission critical communication required by the Smart Grid. Critical grid monitoring and control applications measure latency in milliseconds across hundreds or thousands of miles. Commercial mobile network measure response in human time (Seconds).

iv. Security: What are the major security challenges, and the relative merits and deficiencies of private utility networks versus alternative solutions provided by commercial network providers, such as VPNs? Do the security requirements and the relative merits of commercial versus private networks depend on the specific Smart Grid application? If so, how?

Response

The security of a native commercial public carrier network does not meet the NERC-CIP requirements for utility services. If commercial networks were to be used, it might be necessary to add security mechanism, such as VPN, to encrypt the session. However, two-factor authentication VPN might introduce additional latency.

v. Coordination: Are there benefits or technical requirements to coordinate potential allocation of spectrum to the Smart Grid communications with other countries? What are they?

Response

The electrical grids between the United States and Canada are interconnected; a fault on the grid in the US can cascade to Canada and back. The Canadian government has allocated 30 MHz of dedicated spectrum in the 1.8 GHz band for smart grid usage. The potential benefits of a coordinated spectrum allocation would include a more defined roadmap for Smart Grid wireless device design for the vendors and possible closer data sharing and collaboration between cross-border utilities for optimized operation of the

North American power grid. Broader coordination would allow more effective use of a scarce resource and promote economies of scale.

vi. Spectrum allocation: Are there any specific requirements associated with Smart Grid communications that require or rule out any specific band, duplexing scheme (e.g., FDD vs TDD), channel width, or any other requirements or constraints?

Response
There are many narrowband channel with bandwidth of 12.5kHz to 50kHz there is no dedicated broadband spectrum. There is a real need for a dedicated broadband. Bandwidth needs to be allocated similar to the 30MHz that has been allocated in the 1.8GHz band in Canada.

g. If spectrum were to be allocated for Smart Grid applications, how would this impact current, announced and planned Smart Grid deployments? How many solutions would use allocated spectrum vs. current solutions? Which Smart Grid applications would likely be most impacted?

Response
If spectrum were allocated, it would be worked into rolling deployment plans as timelines and budgets allowed. Depending on the spectrum allocated (bandwidth and frequency) and sharing rules, it would likely be used for more critical applications such as real-time monitoring and control. There would still be a number of different technologies and unlicensed bands used to create the Smart Grid. What would be eliminated would be using unlicensed bands beyond their performance and reliability limits. Dedicated spectrum combined with well developed standards and system designs would provide consistent performance that could be guaranteed over time.

## 9) Real-Time Data

The Smart Grid promises to enable utility companies and their customers to reduce U.S. energy consumption using a variety of technologies and methods. Some of the most promising of these methods use demand response, in which utility companies can directly control loads within the home or business to better manage demand, or give price signals to encourage load shedding. Other methods reduce energy consumption simply by providing consumers access to their consumption information, via in-home displays, web portals, or other methods. Central to all of these techniques is energy consumption and pricing data.

a. In current Smart Meter deployments, what percentage of customers have access to real-time consumption and/or pricing data? How is this access provided?

Response

Globally, I believe the answer to this question is consistent. At this point, close to zero (0) percent of the customers have access to real-time consumption and/or pricing data. The intent of most of the current solutions being deployed is to make this data available from the meter, however these solutions are not deployed at any scale to this point. There is still ongoing work to further develop the Smart Energy Profile, for which most of the meters and in-home devices will use to communicate the above. For this reason, NIST made it a priority to ensure that current deployments have the ability to be remotely upgraded. To this point, a number of utilities are making consumption data available via a web portal, however this data is not made available in real-time … at best it's yesterday's data.

b. What are the methods by which consumers can access this data (e.g., via Smart Meter, via a utility website, via third-party websites, etc.)? What are the relative merits and risks of each method?

Response

As I mentioned above, the predominant approach to this point is to utilize functionality provided by certain Meter Data Management (MDM) applications and make data available via a utility or third-party website. This data is NOT available in real-time, primarily due to the communications networks that are being used and the lack of capacity for these networks to provide this data in any sort of real-time fashion. Ultimately, in GE's opinion, consumption data will need to be available in "near real-time" directly to the consumer over some in-home device or a web server based application in the meter. We believe that it will be the consumers desire to see immediate reactions to their consumption upon some action that they take (demand drops immediately upon them turning their air conditioner from 75 degrees to 78 degrees). It is also our belief that this consumption data, if the networks are capable of providing it, could be used for "social energy networking" type applications (ie, you could compare yourself to your neighbors, compare yourself to similar sized homes, similar communities, etc).

c. How should third-party application developers and device makers use this data? How can strong privacy and security requirements be satisfied without stifling innovation?

Response

We won't necessarily get into how developers will use this data as that's a fairly broad question … but one can imagine a parallel with the Apple iPhone and the numerous applications that are now available for this device. What will make applications available is the use of open and interoperable standards for the devices and interfaces for the Home Area Networks. GE has long been a proponent of open and interoperable standards … the long standing solutions in this area made of up proprietary technologies are at the end of their life cycle.

d. What uses of real-time consumption and pricing data have been shown most effective at reducing peak load and total consumption? We welcome detailed analyses of the relative merits and risks of these methods.

Response

There are a number of studies conducted so far that do indicate that price differentiated rates do cause consumers to take action to reduce their usage during times of higher price. What is also demonstrated is that providing systemic solutions vs. manual solutions is more effective. As with most of the solutions, there is some "rebound effect" or higher consumption than normal after the higher price time period is concluded (air conditioner running longer after a higher price period to cool the house back down). In general, the reduction in consumption is anywhere between 5% and 15% overall. The problem with all of the studies to date is determining if they have lasting effect … without systemic solutions, how long will a consumer stay engaged with looking at a device and taking some manual intervention to change their usage patterns? It's our belief that systemic solutions will be required to provide lasting and sustained benefits to both the consumer and the utility. For this reason, networking of devices will be essential for the future solutions.

e. Are there benefits to providing consumers more granular consumption data? We welcome studies that examine how consumer or business behavior varies with the type and frequency of energy consumption data.

Response

It's unproven at this point exactly how granular the information must be, but what is being required is the real-time nature of the data availability to the consumer. Per one of the previous answers, we believe that typical consumer behavior will require near real-time response to any given consumer action (a consumer wouldn't want to wait 10 minutes after they turned down their air conditioner to see if and how much their instantaneous demand changed … they will want to see this within 10 seconds or so)

f. What are the implications of opening real-time consumption data to consumers and the energy management devices and applications they choose to connect?

Response

It's not clear that there are any real downsides to providing this data, but rather improvements in how energy management devices can and will manage energy efficiency in the future. For instance, GE is developing a suite of smart appliances which will be able to change their operating modes based on price signals or potentially based on the energy usage of the other devices (ie, the refrigerator would go into a lower energy mode if the dryer is on). This will have a positive effect on the utility as this all works to lower those "peak demand" events that they currently have to build and manage their networks to support.

## 10) Home Area Networks

We seek to understand the ways in which utilities, technology providers and consumers will connect appliances, thermostats, and energy displays to each other, to the electric meter, and to the Internet.

As a provider of technologies across the spectrum of technologies to be used for the Smart Grid, we believe we have good insights into the various applications and technologies to be used in home area networks.

a. Which types of devices (e.g., appliances, thermostats, and energy displays, etc.) will be connected to Smart Meters? What types of networking technologies will be used? What type of data will be shared between Smart Meters and devices?

Response

It is our belief that a potentially large number of device types will connect to Smart Meters including, but not limited to, appliances, water heaters, thermostats, display devices, load control switches, pool pumps and various other control devices, plug-in vehicles, distributed energy resources (photovoltaics, wind, etc.), energy storage, personal computers, energy management systems, gateway devices, routers, repeaters, lighting systems, as well as many other device types. Further, we believe that as innovation in the market occurs, device types not previously considered would be added. As such, we believe the interface and protocols from the Smart Meter to other devices should support principles such as extensibility, loose coupling, and clean layers to allow communications from Smart Meters into a home area network to be largely agnostic to the types of devices in the home area network.

The specific technologies we are currently using in our Smart Meters include ZigBee (IEEE 802.15.4 MAC/PHY) and HomePlug AV (draft IEEE P1901). In the future, we may see the addition of technologies such as HomePlug Green PHY and Wi-Fi (IEEE 802.11).

The data shared between a Smart Meter and a home area network certainly depends on the architecture and information available to the Smart Meter. At a minimum, Smart Meters can share basic metrology information such as consumption data and instantaneous demand. Other data that may be shared include bi-directional metrology information, price communication information, direct and indirect load control signals, prepayment and billing information, time, simple text messages, greenhouse gas and environmental information, metrology information from other utilities such as gas and water, firmware updates to devices, and many security information exchanges including authentication, authorization, and auditing data. We support and strongly recommend alignment around the Smart Energy Profile specification.

b. Which types of devices (e.g., appliances, thermostats, and energy displays, etc.) will be connected to the Internet? What types of networking technologies will be used? What type of data will be shared between these devices and the Internet?

<u>Response</u>

We envision that, if architected correctly, a connection to the Internet will be extremely similar, if not identical, to the Smart Meter connection, dependent on the needs of the consumer and utility. As such, please reference our response in section a.

c. We welcome analyses that examine the role of broadband requirements for Home Area Networks that manage energy loads or deliver other energy management services.

<u>Response</u>

Although unable to provide in-depth analyses on the role of broadband requirements for Home Area Networks at this time, we certainly envision many applications that could create a need for broadband Home Area Network connectivity including, but not limited to, plug-in vehicle roaming, device firmware updates, increased security requirements, near real-time communication of metrology information, and near real-time communication of pricing information as energy prices become more dynamic.